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(54) High cross correlation dynamic channel assignment for sectorized cells

Dynamische Kanalzuweisung mit hoher Kreuzkorrelation für Sektorenzellen

Allocation dynamique de canaux à corrélation croisée élevée pour cellules sectorisées

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- **IEEE INTERNATIONAL CONFERENCE ON SELECTED TOPICS IN WIRELESS COMMUNICATIONS, 1992, VANCOUVER., 25 June 1992, NEW-YORK (US) pages 340 - 343 I. BRODIE 'PERFORMANCE OF DYNAMIC CHANNEL ASSIGNEMENT TECHNIQUES IN A CELLULAR ENVIRONMENT'**

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Description

[0001] The present invention relates generally to cellular communication systems, and more specifically to dynamic assignment of channels to mobile stations from a base station using an array of antennas respectively covering sectors of the service area of the base station.

[0002] EP-A-0 430 173 describes a method of assigning radio communication channels to each of a plurality of mobile stations.

[0003] The capacity of a cellular mobile communication system may be increased by reducing the size of the cells so that the total number of channels available per unit area is increased. This is achieved in practice by the process of "cell splitting" where new base stations are established. As the cells are split into smaller sizes, the co-channel interference from distant cells increases. One way of reducing the level of co-channel interference is to use directional antennas at base stations, with each antenna illuminating or covering a sector of the cell, whereas ominidirectional antennas are used in non-sectorized cells.

[0004] Dynamic channel assignment schemes are known for efficient utilization of channels, and used for systems of non-sectorized cells. For sectorized cells, a dynamic channel assignment scheme is described in a paper "Channel Segregation, A Distributed Adaptive Channel Allocation Scheme for Mobile Communication Systems", Y. Furuya et al., Second Nordic Seminar on Digital Land Mobile Radio Communication, Stockholm, 1986, pages 311-315. According to the proposed scheme priorities are assigned to a list of available channels according to past records of co-channel interference. On receiving a request from a mobile station, a channel is selected from the list according to the priorities so that the mobile station has a reduced chance of encountering co-channel interference. A dynamic channel assignment scheme for efficient utilization of channels in sectorized cells is described in a paper "Adaptive Channel Allocation in a TIA IS-54 System", H. Andersson et al., Vehicular Technology Conference, 1992, pages 778 to 781. According to this scheme, carrier-to-interference ratio is used as criteria for assigning priorities to available channels.

[0005] However, there is still a need for improvements in dynamic channel assignment scheme for sectorized cells in terms of the utilization of channels, the number of channel selection attempts for each request, and the probability of co-channel interference. More specifically, assume that, in a sectorized cellular communication network, first and second mobile stations are respectively communicating with first and second base stations. The signal from the first base station may be received by the distant, second mobile station as an undesired downlink signal and produce a significant level of interference, while the signal from the first mobile station may be received by the second base station as an undesired uplink signal. If the directional antenna of the second base station which is being used for the second mobile station is oriented in a direction away from the first base station, the undesired uplink signal from the first mobile station will produce a low level of interference. Since interference is currently detected only from a signal received by the antenna used for a mobile station of interest, the cross correlation for co-channel interference between the uplink and downlink signals of the mobile station is low.

[0006] Because of the low cross correlation, the current dynamic channel assignment schemes are not satisfactory in respect of the utilization of channels, the number of channel selection attempts for each request, and the probability of co-channel interference.

[0007] IEEE International Conference on Selected Topics in Wireless Communications, 1992, Vancouver, 25 June 1992, New York, US, pages 340-343, I. Brodie, "Performance of Dynamic Channel Assignment Techniques in a Cellular Environment" reports on the perfomance of several dynamic assignment techniques, and specific attention is given to sectorized configurations. This publication describes a base station having a plurality of antennas having different orientations to cover sector areas. A dynamic channel assignment technique is used to assign a channel according to carrier-to-interference ratio. The interference is calculated by summing the signal received from all the interfering sources transmitting on the same channel. It is described in this publication that, when a call attempt is made, the mobile station selects the base station and sector with the least path loss (not necessarily the closest) and, if there are any acceptable channels, one is selected using one of the DCA methods.

[0008] It is an object of the present invention to provide dynamic assignment which ensures high degree of cross correlation for co-channel interference between uplink and downlink signals.

[0009] This object is achieved with a dynamic channel assignment method according to independent claims 1, 3, or 4

[0010] The present invention will be described in further detail with reference to the accompanying drawings, in which:

Fig. 1 is a block diagram of a cellular communication network in which the first embodiment of the present invention is implemented;

Fig. 2 is a flowchart illustrating a sequence of operations performed by a base station and a mobile station according to the first embodiment;

Fig. 3 is an illustration of directivity patterns of a four-antenna array used in the cellular network according to a second embodiment of the present invention;

Fig. 4 is a flowchart illustrating a sequence of operations performed by a base station according to the second embodiment;

Fig. 5 is a block diagram of a cellular communication

network in which the third embodiment of the present invention is implemented ;

Fig. 6 is a flowchart illustrating a sequence of operations performed by a base station according to the third embodiment;

Fig. 7 is an illustration of directivity patterns of a three-antenna array used in the cellular network according to a fourth embodiment of the present invention; and

Fig. 8 is a flowchart illustrating a sequence of operations performed by a base station according to the fourth embodiment of the present invention.

[0011] In Fig. 1, there is shown an exemplary cellular communication network in which the first embodiment of the present invention is implemented. The network comprises a plurality of identical base stations arranged according to a repeat pattern based upon a known frequency reuse plan. Each base station has an array of four directional antennas "a", "b", "c" and "d" each with a directivity pattern that covers a sector of 90 degrees on the horizontal plane, thus dividing the coverage area of the base station equally into four sectorized areas A, B, C and D. For simplicity only four base stations 11 to 14 are illustrated, which may be adjacent to each other or spaced apart at least one cell-site distance.

[0012] For purposes of control as well as speech communication, a downlink channel is established in a base-to-mobile direction and an uplink channel in a mobile-to-base direction. In this specification, a desired signal on any uplink and downlink channels is designated Dup and Ddn, respectively, and an undesired (co-channel interference) signal on any uplink and downlink channels as Uup and Udn, respectively.

[0013] According to the first embodiment of the present invention, all base stations select any pair of uplink and downlink speech channels which are allocated to the cellular network as a whole. As a typical example, communications are established on a speech channel CH1 between mobile (or personal) station 22 and base station 12, on channels CH2, CH3 between mobiles 23, 24 and base station 13, and on channels CH4, CH5 between mobiles 25, 26 and base station 14. It is therefore likely that the antenna "b" of base station 11 will be exposed to the transmissions of undesired signals Uup from mobile stations 23, 24 and 25 (and hence the undesired signals are indicated as Uupb), and the antenna "c" of base station 11 will be exposed to the transmissions of undesired signals Uupc from mobile stations 22 and 26. In response to a call request signal from a mobile station 21, the base station 11 assigns a channel to the mobile station according to a channel assignment algorithm of the present invention, using undesired uplink signals from the surrounding base stations.

[0014] The channel assignment algorithm of the first embodiment is shown in Fig. 2. In response to a call request signal sent from a mobile or personal station on an uplink control channel, the channel assignment routine begins. This call request is received by one of its antennas which is, for convenience, designated "x" (step 200). The base station proceeds to detect the power level of the received carrier and identifies it as a desired signal Dupx (step 201). A variable "i" is set equal to 1 at step 202 and a channel identified by the variable i is selected (step 203). Exit then is to step 204 to detect the power levels of undesired signals Uupa, Uupb, Uupc and Uupd, which are received by antennas a, b, c and d, respectively. Control proceeds to step 205 to determine the highest of the detected power levels and set it as Uupi as a possible interference signal. A ratio Dupx/Uupi is then calculated and compared with a predetermined value K (step 206). If the ratio is greater than K, control branches at step 206 to step 207 to set the channel i as a candidate channel, and proceeds to step 208 to determine whether all channels are tested. If the answer is negative, control branches at step 208 to step 209 to increment the variable i by one and returns to step 203 to repeat the process. If the decision at step 206 is negative, control branches out to step 208, skipping step 207.

[0015] In Fig. 1, the base station 11 is assumed to receive the call request from mobile 21 at antenna "a" to detect the power level of the uplink signal Dupa, and to receive only one undesired signal for each channel. Therefore, with respect to channel CH1 (channel number i=1), the undesired uplink signal Uupc(1) from mobile station 22 is classified as having a highest power level at step 205. As the candidate determination process is repeated, channels CH2, CH3, CH4 and CH5 are successively tested, yielding ratios Dupa/Uup2, Dupa/Uup3, Dupa/Uup4, Dupa/Uup5. If the undesired uplink signals Uupc(1), Uupb(2) and Uupb(3) are relatively strong and their ratios Dupa/Uup1, Dupa/Uup2 and Dupa/Uup3 are determined at step 206 to be smaller than K, channels CH1, CH2 and CH3 will be discarded and the remaining channels CH4 and CH5 will be recorded in a memory as candidate channels having a high degree of cross-correlation with the desired downlink signal Ddn.

[0016] Following the execution of step 208, control now enters a channel selection process. At step 210, a decision is made on whether candidate channels are present or not If not, control exits to step 217 to send a busy tone to mobile station 21. If the answer is affirmative, control branches at step 210 to step 211 to select a candidate channel corresponding to the signal Uupi having the highest power level from the list of candidates determined by step 207 and set the selected candidate channel as a channel j. Exit then is to step 212 to transmit a carrier on the selected channel j from base station 11 and send a command over the control channel to mobile station 21 to measure the power level of the transmitted carrier to determine a value Ddn. Base station 11 then ceases the transmission of the carrier and commands mobile station 21 to measure the level of noise detected on channel j to determine a value Udn. At step

213, mobile station 21 calculates the ratio Ddn/Udn and compares it with a prescribed threshold value M and sends a signal indicating whether the ratio is higher than the threshold.

[0017] If the signal indicates that the ratio is smaller than the threshold (step 213), base station 11 removes the channel j from the list of the candidates (step 214) and returns to step 210 to check to see if candidate channels still exist. If the answer is affirmative, the channel of next highest is selected as channel j (step 211), and steps 212 and 213 are repeated. If the signal from mobile station 21 indicates that the ratio is greater than the threshold M, channel j is assigned to the mobile station (step 215) and a two-way connection is established on the assigned channel.

[0018] The selection of a maximum power level at step 211 with priority enables base station 11 to eventually assign a group of channels having reduced frequency separations from each other at a cost of somewhat increase in co-channel interference, a compromise between the conflicting factors of channel utilization efficiency and co-channel interference. As a trade-off between these conflicting factors, other known channel assignment approaches are available. However, regardless of the approaches taken by the channel assignment subroutine (steps 210 to 216), the candidate selection subroutine (steps 203 to 208) of the present invention enables each base station of the cellular communication network to make an optimum decision on channel utilization efficiency and co-channel interference. Additionally, the present invention enables each base station to reduce the occurrence of co-channel interference and to reduce the number of repeated attempts to determine the best channel.

[0019] According to a second embodiment of the present invention, the determination of the undesired signal of highest power Uupi at step 205 of Fig. 2 is modified. According to this modification, when an undesired signal is detected by two or more antennas, two of the signals having the highest and second highest power levels are selected and the highest power level is compensated for with a correction factor determined by the angle of arrival of the undesired signal. As illustrated in Fig. 3, each antenna has an identical directivity pattern P on a horizontal plane and the antenna directivity is represented by relative gain (a fraction of unity) with respect to the main axis of the antenna. If an undesired signal arrives at an angle α with respect to a reference angle (zero degrees) as shown in Fig. 3, it intersects the directivity patterns Pa and Pb of antennas "a" and "b" at points where relative gains are Ga and Gb, respectively, which are fractions of unity with respect to the main axes of their antennas. By representing the power levels of the signals received by antennas "a" and "b" as Uupa and Uupb, respectively, the power ratio Uupa/Uupb is equal to the antenna gain ratio Ga/Gb. Therefore, the relation Ga/Gb = Uupa/Uupb holds. The arrival angle of any undesired signal can be determined as being equal to α if the relation $Ga(\alpha)/Gb(\alpha)$ = Uupa/Uupb is satisfied. With the arrival angle being determined for antenna a, the highest value Uupa is divided by relative gain $Ga(\alpha)$ to obtain Uupi which is equivalent to a signal arriving in the direction of the main axis of the antenna and detected with the gain of unity.

[0020] In a practical aspect, the relative gain $Gx(\alpha)$ of antenna "x" is stored in a location of an antenna gain memory, not shown, in which relationships between arrival angles and relative antenna gains are mapped for each pair of adjacent antennas.

[0021] Fig. 4 shows a flowchart for implementing the second embodiment of the present invention which is similar to the flowchart of Fig. 2 with the exception that step 205 of Fig. 2 is replaced with steps 400, 401, 402 and 403. Following the execution of step 204, control exits to step 400 to select an undesired signal of highest level from antenna x1 and set the power level of the signal as Uupx1. Exit then is to step 401 to select an undesired signal of the second highest level from antenna x2 and set the power level of the signal as Uupx2. At step 402, the antenna gain memory is searched for $Gx1(\alpha)$ and $Gx2(\alpha)$ which establish the relation $Gx1(\alpha)/Gx2(\alpha)$ = Uupx1/Uupx2 and determines the angle of arrival α from this relationship. At step 403, Uupx1 is divided by $Gx1(\alpha)$ to determine the undesired signal of channel "i" with the highest power level Uupi. Step 403 is followed by step 206 to check to see if the ratio Dupx/Uupi is greater than the threshold value K.

[0022] According to a third embodiment of the present invention which is shown in Fig. 5, each sector area of all the base stations is allocated a group of channels which are different from the channels of the other sectors of all the base stations but identical to those allocated to the sector areas of the other base stations which are illuminated by the antennas of the same orientation as the antenna of that sector area. For example, sector areas A of all cell site stations are allocated the same group of channels CH11, CH12, which differ from those allocated to the other sector areas. With this channel allocation plan, mobile station 21 of base station 11 is likely to be affected by undesired signals from antennas "a" of the other base stations 12, 13 and 14 as indicated by arrows Udn(11) on channel CH11 from base station 12, Udn(12) on channel CH12 from base station 13 and Udn(13) on channel CH13 from base station 14. According to this embodiment, cross correlation is detected between undesired signals received by a pair of antennas oriented in opposite directions. Thus, for mobile station 21, antennas "a" and "c" of base station 11 are used for determining the cross correlation.

[0023] Fig. 6 shows a flowchart for implementing the third embodiment of the present invention which is similar to the flowchart of Fig. 2 with the exception that steps 204 and 205 of Fig. 2 are replaced with steps 600 and 601. Following the execution of step 203, control exits to step 600 to detect power levels of undesired signals Uupx and Uupy received at antennas "x" and "y" of mu-

tually opposite orientations, using correlation receivers, not shown. Control advances to step 601 to determine the highest of the signals Uupx and Uupy and stores it as Uupi for channel i. Exit then is to step 206 to determine whether the ratio of the power level Dupx of downlink signal received at mobile station 21 to Uupi is greater than the threshold K.

[0024] Therefore, in the example illustrated in Fig. 5, signal Uupc(11) from mobile station 22 is received by antenna "c" at cell site 11 and detected by the correlation receiver coupled to this antenna at step 600 when the variable i is set equal to channel CH11 and signals are received by antenna "a". If the signal Uupc(11) is higher than the signals received by antenna "a", it is selected as Uup1 at step 601 and the ratio Dupx/Dup1 is compared with K at step 206. As the candidate selection subroutine of Fig. 6 proceeds at base station 11, a signal Uupa(12) on channel CH12 from mobile station 23 is received by antenna "a" and detected at step 600 when variable i is set equal to channel CH12 and signals are received by antenna "c". If the signal Uupa(12) is higher than the signals received by antenna "c", it is selected as Uup2 at step 601 and the ratio Dupx/Uup2 is compared with K at step 206. In the same manner, a signal Uupc(13) on channel CH13 from mobile station 25 is detected by antenna "c" when variable i is set equal to CH13 and compared with signals received by antenna "a" and will be selected as Uup3, and the ratio Dupx/Uup3 is compared with K. If the results of the comparisons successively made at step 206 in the above process indicate that the respective ratios are higher than K, channels CH11, CH12 and CH13 will be stored as candidate channels at step 207. Therefore, if signal Uupc (11) is of highest power level, the ratio Ddn(11)/Udn(11) will be determined by mobile station 21 to be higher than threshold M at step 213 in the subsequent channel assignment subroutine (see Fig. 2) and channel CH11 will be assigned to mobile station 21.

[0025] The third embodiment of this invention can be used to advantage if an even number of antennas is provided for all base stations. However, if there exists at least one base station having an odd number of antennas, the third embodiment cannot simply apply. To this end, a three-antenna array is illustrated in Fig. for a base station 11 in the network of Fig. 5 as a fourth embodiment of the present invention. As shown, antennas "a", "b" and "c" have identical directivity patterns Pa, Pb and Pc, respectively, on a horizontal plane and the directivity is represented by relative gains Ga, Gb, Gc each having a fraction of unity relative to their main axis in a manner similar to those shown in Fig. 3. If an undesired signal arrives at an angle β with respect to the zero-degree reference, component signal Uupb will be of highest level and component signal Uupc will be of second highest level. Therefore, the relation $Gb(\beta)/Gc(\beta) = Uupb/Uupc$ is established. By using this relation, the angle of arrival β is determined and a correction is made on the highest power level by dividing it with Gb(β) and then multiplying with Gv(β) which is the relative gain at angle β of a virtual directivity pattern Pv. This virtual pattern is obtained by reflecting a copy of the directivity pattern Pa of antenna "a". The relative gain Gb(β), Gc(β) of a pair of adjacent antennas "b" and "c" and the relative gain Gv(β) are stored in a memory, not shown, in which relationships are mapped between arrival angles and relative antenna gains for each pair of adjacent antennas and a virtual directivity pattern resulting from each pair of these antennas.

[0026] Fig. 8 is a flowchart for implementing the fourth embodiment of the present invention. The flowchart of Fig. 8 is similar to that shown in Fig. 2 with the exception that steps 204 and 205 of Fig. 2 are replaced

Claims

1. A dynamic channel assignment method for a base station of a mobile communication system, wherein the base station has a plurality of antennas (a. b, c. d; a, b, c) and is capable of selecting one of a plurality of channels of said system for said antennas and corresponding sector areas, the base station being responsive to a call request for a communication with a mobile station for evaluating the qualities of said channels and assigning one of the evaluated channels to the mobile station according to their qualities, the method comprising the steps of:

   A) determining, for each of said channels, the interference levels of undesired uplink signals (Uupa, Uupb, Uupc, Uupd; Uupx, Uupy; Uupy1, Uupy2) received by all of said antennas;
   B) determining, for each of said channels, the highest level (Uupi) of said undesired uplink signals;
   C) selecting one of said channels depending on the highest level (Uupi) of the selected channel relative to the highest levels (Uupi) of other channels;
   D) assigning the selected channel to the mobile station if the selected channel has acceptable quality; and
   E) repeating the steps C) and D) if the selected channel has no acceptable quality,

   wherein the step B) further comprises:

   B_1) determining, for each of said channels, first and second highest interference levels of said undesired uplink signals and selecting first and second antennas (a, b) of said plurality of antennas corresponding to the first and second highest interference levels;
   B_2) determining the arrival angle (α) of said undesired uplink signal of the first highest interference level using directivity patterns of said first

and second antennas (a, b); and
B_3) determining, for each of said channels, said highest interference level using said arrival angle.

2. A dynamic channel assignment method according to claim 1, wherein the step B_2) comprises determining a first relative gain (Ga) of the undesired uplink signal of the first highest interference level using the directivity pattern of said first antenna (a) and a second relative gain (Gb) of the undesired uplink signal of the second highest interference level using the directivity pattern of said second antenna (b), said first and second relative gains (Ga, Gb) establishing a proportional relationship with said first and second highest interference levels, and

wherein the step B_3) comprises determining said highest interference level using the first relative gain (Ga).

3. A dynamic channel assignment method for a base station of a mobile communication system, wherein the base station has a plurality of antennas (a, b, c, d; a, b, c) and is capable of selecting one of a plurality of channels of said system for said antennas and corresponding sector areas, the base station being responsive to a call request for a communication with a mobile station for evaluating the qualities of said channels and assigning one of the evaluated channels to the mobile station according to their qualities, the method comprising the steps of:

A) determining, for each of said channels, the interference levels of undesired uplink signals (Uupa, Uupb, Uupc Uupd; Uupx, Uupy; Uupy1, Uupy2) received by all of said antennas;
B) determining, for each of said channels, the highest level (Uupi) of said undesired uplink signals;
C) selecting one of said channels depending on the highest level (Uupi) of the selected channel relative to the highest levels (Uupi) of other channels;
D) assigning the selected channel to the mobile station if the selected channel has acceptable quality; and
E) repeating the steps C) and D) if the selected channel has no acceptable quality,

wherein a unique set of channels is allocated to each of said antennas which are oriented in identical directions to the antennas of other base stations, and

wherein the step A) comprises determining, for each of said channels, the levels (Uupx, Uupy) of said undesired signal detected by first and second antennas (x, y) which are oppositely oriented to each other.

4. A dynamic channel assignment method for a base station of a mobile communication system, wherein the base station has a plurality of antennas (a, b, c, d; a, b, c) and is capable of selecting one of a plurality of channels of said system for said antennas and corresponding sector areas, the base station being responsive to a call request for a communication with a mobile station for evaluating the qualities of said channels and assigning one of the evaluated channels to the mobile station according to their qualities, the method comprising the steps of:

A) determining, for each of said channels, the interference levels of undesired uplink signals (Uupa, Uupb, Uupc Uupd; Uupx, Uupy; Uupy1, Uupy2) received by all of said antennas;
B) determining, for each of said channels, the highest level (Uupi) of said undesired uplink signals;
C) selecting one of said channels depending on the highest level (Uupi) of the selected channel relative to the highest levels (Uupi) of other channels;
D) assigning the selected channel to the mobile station if the selected channel has acceptable quality; and
E) repeating the steps C) and D) if the selected channel has no acceptable quality,

wherein the step A) comprises determining, for each of said channels, --first and second interference levels (Uupy1, Uupy2) of said undesired signals detected respectively from first and second antennas (y_1, y_2) which form a virtual directivity pattern oriented in a direction opposite to the directivity pattern of a third antenna (x),

wherein the step B) comprises:

B_1) determining the arrival angle (β) of said undesired signal using directivity patterns of the first and second antennas (y_1, y_2);
B_2) correcting one of the determined interference levels (Uupy1, Uupy2) according to said arrival angle; and
B_3) selecting the highest one of the corrected interference level and the uncorrected level.

5. A dynamic channel assignment method according to claim 4, wherein the step B_1) comprises determining a first relative gain (Gb) of the undesired signal of the first interference level on the directivity pattern of said first antenna (y_1), a second relative gain (Gc) of the undesired signal of the second interference level on the directivity pattern of said second antenna (y_2), and a third relative gain (Gv) of the undesired signal using said virtual directivity pattern, the first and second relative gains (Gb, Gc) establishing a proportional relationship with the first

and second interference levels (Uupy1, Uupy2), and

wherein the step B_2) comprises correcting the interference level (Uupy1) of the undesired signal detected by the first antenna (y_1) using the first and third relative gains (Gb, Gv).

6. A dynamic channel assignment method according to any of claims 1 to 5 wherein the step C) comprises the step C_1) of selecting one of a plurality of uplink channels depending on said highest level (Uupi) of the selected channel relative to the highest levels (Uupi) of other channels, and wherein the step D) comprises the step D_1) of assigning the selected uplink channel and a corresponding downlink channel to the mobile station.

7. A dynamic channel assignment method according to claim 6, wherein the step D) comprises the steps of:

   transmitting a carrier of said corresponding downlink channel to the mobile station; and
   commanding the mobile station to determine the quality of the transmitted carrier and informing the base station of the determined quality.

Patentansprüche

1. Dynamisches Kanalzuweisungsverfahren für eine Basisstation eines mobilen Kommunikationssystems, wobei die Basisstation mehrere Antennen (a, b, c, d; a, b, c) aufweist und in der Lage ist, einen der mehreren Kanäle des Systems für die Antennen und entsprechende Sektorbereiche auszuwählen, wobei die Basisstation auf eine Rufanforderung für eine Kommunikation mit einer Mobilstation anspricht, um die Qualitäten der Kanäle zu bewerten und einen der bewerteten Kanäle entsprechend ihren Qualitäten der Mobilstation zuzuweisen, wobei das Verfahren die Schritte aufweist:

   A) Bestimmen der Interferenzpegel unerwünschter Uplink-Signale (Uupa, Uupb, Uupc, Uupd; Uupx, Uupy; Uupy1, Uupy2), die durch alle Antennen empfangen werden, für jeden der Kanäle;
   B) Bestimmen des höchsten Pegels (Uupi) der unerwünschten Uplink-Signale für jeden der Kanäle;
   C) Auswählen eines der Kanäle in Abhängigkeit vom höchsten Pegel (Uupi) des ausgewählten Kanals bezüglich des höchsten Pegels (Uupi) anderer Kanäle;
   D) Zuweisen des ausgewählten Kanals zur Mobilstation, wenn der ausgewählte Kanal eine geeignete Qualität aufweist;
   E) Wiederholen der Schritte C) und D), wenn der ausgewählte Kanal keine geeignete Qualität aufweist;

   wobei Schritt B) ferner aufweist:

   B_1) Bestimmen eines ersten und eines zweiten höchsten Interferenzpegels der unerwünschten Uplink-Signale für jeden der Kanäle und Auswählen einer ersten und einer zweiten Antenne (a, b) der mehreren Antennen, die dem ersten und dem zweiten höchsten Interferenzpegel zugeordnet sind;
   B2) Bestimmen des Eintreffwinkels (α) des unerwünschten Uplink-Signals des ersten höchsten Interferenzpegels unter Verwendung von Antennenrichtwirkungsmustern der ersten und der zweiten Antenne (a, b); und
   B_3) Bestimmen des höchsten Interferenzpegels unter Verwendung des Eintreffwinkels für jeden der Kanäle.

2. Dynamisches Kanalzuweisungsverfahren nach Anspruch 1, wobei Schritt B_2) das Bestimmen einer ersten relativen Verstärkung (Ga) des unerwünschten Uplink-Signals mit dem ersten höchsten Interferenzpegel unter Verwendung des Antennenrichtwirkungsmusters der ersten Antenne (a) und einer zweiten relativen Verstärkung (Gb) des unerwünschten Uplink-Signals mit dem zweiten höchsten Interferenzpegel unter Verwendung des Antennenrichtwirkungsmusters der zweiten Antenne (b) aufweist, wobei durch die erste und die zweite relative Verstärkung (Ga, Gb) eine Proportionalitätsbeziehung mit dem ersten und dem zweiten höchsten Interferenzpegel eingerichtet wird, und

   wobei Schritt B3) das Bestimmen des höchsten Interferenzpegels unter Verwendung der ersten relativen Verstärkung (Ga) aufweist.

3. Dynamisches Kanalzuweisungsverfahren für eine Basisstation eines mobilen Kommunikationssystems, wobei die Basisstation mehrere Antennen (a, b, c, d; a, b, c) aufweist und in der Lage ist, einen der mehreren Kanäle des Systems für die Antennen und entsprechende Sektorbereiche auszuwählen, wobei die Basisstation auf eine Rufanforderung für eine Kommunikation mit einer Mobilstation anspricht, um die Qualitäten der Kanäle zu bewerten und einen der bewerteten Kanäle entsprechend ihren Qualitäten der Mobilstation zuzuweisen, wobei das Verfahren die Schritte aufweist:

   A) Bestimmen der Interferenzpegel unerwünschter Uplink-Signale (Uupa, Uupb, Uupc, Uupd; Uupx, Uupy; Uupy1, Uupy2), die durch alle Antennen empfangen werden, für jeden der Kanäle;

B) Bestimmen des höchsten Pegels (Uupi) der unerwünschten Uplink-Signale für jeden der Kanäle;

C) Auswählen eines der Kanäle in Abhängigkeit vom höchsten Pegel (Uupi) des ausgewählten Kanals bezüglich der höchsten Pegel (Uupi) anderer Kanäle;

D) Zuweisen des ausgewählten Kanals zur Mobilstation, wenn der ausgewählte Kanal eine geeignete Qualität aufweist;

E) Wiederholen der Schritte C) und D), wenn der ausgewählte Kanal keine geeignete Qualität aufweist;

wobei jeder der Antennen, die in die gleiche Richtung ausgerichtet ist wie die Antennen anderer Basisstationen, ein einziger Satz von Kanälen zugewiesen wird; und

wobei Schritt A) für jeden der Kanäle das Bestimmen der Pegel (Uupx, Uupy) des unerwünschten Signals aufweist, das durch die erste und die zweite Antenne (x, y) erfaßt wird, die entgegengesetzt zueinander ausgerichtet sind.

4. Dynamisches Kanalzuweisungsverfahren für eine Basisstation eines mobilen Kommunikationssystems, wobei die Basisstation mehrere Antennen (a, b, c, d; a, b, c) aufweist und in der Lage ist, einen der mehreren Kanäle des Systems für die Antennen und entsprechende Sektorbereiche auszuwählen, wobei die Basisstation auf eine Rufanforderung für eine Kommunikation mit einer Mobilstation anspricht, um die Qualitäten der Kanäle zu bewerten und einen der bewerteten Kanäle entsprechend ihren Qualitäten der Mobilstation zuzuweisen, wobei das Verfahren die Schritte aufweist:

A) Bestimmen der Interferenzpegel unerwünschter Uplink-Signale (Uupa, Uupb, Uupc, Uupd; Uupx, Uupy; Uupy1, Uupy2), die durch alle Antennen empfangen werden, für jeden der Kanäle;

B) Bestimmen des höchsten Pegels (Uupi) der unerwünschten Uplink-Signale für jeden der Kanäle;

C) Auswählen eines der Kanäle in Abhängigkeit vom höchsten Pegel (Uupi) des ausgewählten Kanals bezüglich der höchsten Pegel (Uupi) anderer Kanäle;

D) Zuweisen des ausgewählten Kanals zur Mobilstation, wenn der ausgewählte Kanal eine geeignete Qualität aufweist;

E) Wiederholen der Schritte C) und D), wenn der ausgewählte Kanal keine geeignete Qualität aufweist;

wobei Schritt A) aufweist: Bestimmen eines ersten und eines zweiten Interferenzpegels (Uupy1, Uupy2) der unerwünschten Signale, die von einer ersten bzw. einer zweiten Antenne (y_1, y_2) erfaßt werden, die ein virtuelles Antennenrichtwirkungsmuster bilden, das in eine dem Antennenrichtwirkungsmuster einer dritten Antenne (x) entgegengesetzte Richtung ausgerichtet ist, für jeden der Kanäle; und

wobei Schritt B) ferner aufweist:

B_1) Bestimmen des Eintreffwinkels (β) des unerwünschten Signals unter Verwendung von Antennenrichtwirkungsmustern der ersten und der zweiten Antenne (y_1, y_2) ;

B_2) Korrigieren eines der bestimmten Interferenzpegel (Uupy1, Uupy2) gemäß dem Eintreffwinkel; und

B_3) Auswählen des höchsten Pegels aus dem korrigierten Interferenzpegel und dem unkorrigierten Pegel.

5. Dynamisches Kanalzuweisungsverfahren nach Anspruch 4,

wobei Schritt B_1) das Bestimmen einer ersten relativen Verstärkung (Gb) des unerwünschten Signals mit dem ersten Interferenzpegel auf dem Antennenrichtwirkungsmuster der ersten Antenne (y_1), einer zweiten relativen Verstärkung (Gc) des unerwünschten Signals mit dem zweiten Interferenzpegel auf dem Antennenrichtwirkungsmuster der zweiten Antenne (y_2), und einer dritten relativen Verstärkung (Gv) des unerwünschten Signals unter Verwendung des virtuellen Antennenrichtwirkungsmusters aufweist, wobei durch die erste und die zweite relative Verstärkung (Gb, Gc) eine Proportionalbeziehung mit dem ersten und dem zweiten Interferenzpegel (Uupy1, Uupy2) eingerichtet wird; und

wobei Schritt B_2) das Korrigieren des Interferenzpegels (Uupy1) des durch die erste Antenne (y_1) erfaßten unerwünschten Signals unter Verwendung der ersten und der dritten relativen Verstärkung (Gb, Gv) aufweist.

6. Dynamisches Kanalzuweisungsverfahren nach einem der Ansprüche 1 bis 5,

wobei Schritt C) den Schritt C_1) zum Auswählen eines von mehreren Uplink-Kanälen in Abhängigkeit vom höchsten Pegel (Uupi) des ausgewählten Kanals bezüglich der höchsten Pegel (Uupi) anderer Kanäle aufweist, und

wobei Schritt D) den Schritt D_1) zum Zuweisen des ausgewählten Uplink-Kanals und eines entsprechenden Downlink-Kanals zur Mobilstation aufweist.

7. Dynamisches Kanalzuweisungsverfahren nach Anspruch 6, wobei Schritt D die Schritte aufweist:

Übertragen eines Trägersignals des entsprechenden Downlink-Kanals zur Mobilstation; und
Anweisen der Mobilstation, die Qualität des übertragenen Trägersignals zu bestimmen, und Informieren der Basisstation über die bestimmte Qualität.

Revendications

1. Procédé dynamique d'assignation de voies pour une station de base d'un système de communication mobile, dans lequel la station de base possède plusieurs antennes (a, b, c, d ; a, b, c) et est capable de sélectionner une voie parmi l'ensemble des voies dudit système pour lesdites antennes ainsi que des zones de secteurs correspondantes, la station de base étant sensible à une demande d'appel pour une communication avec une station mobile dans le but d'évaluer les qualités desdites voies et d'assigner une des voies évaluées à la station mobile en fonction de leurs qualités, le procédé comprenant les étapes consistant à :

   A) déterminer, pour chacune desdites voies, les niveaux de brouillage de signaux de liaisons montantes inopportuns (Uupa, Uupb, Uupc, Uupd ; Uupx, Uupy ; Uupy1, Uupy2) reçus par l'ensemble desdites antennes ;
   B) déterminer, pour chacune desdites voies, le plus haut niveau (Uupi) desdits signaux de liaisons montantes inopportuns ;
   C) sélectionner une desdites voies en fonction du plus haut niveau (Uupi) de la voie sélectionnée par rapport aux plus hauts niveaux (Uupi) d'autres voies ;
   D) assigner la voie sélectionnée au poste mobile lorsque la voie sélectionnée possède une qualité acceptable ; et
   E) répéter les étapes C) et D) lorsque la voie sélectionnée ne possède pas une qualité acceptable,

   dans lequel l'étape B) comprend en outre le fait de :

   B_1) déterminer, pour chacune desdites voies, des premier et deuxième plus hauts niveaux de brouillage desdits signaux de liaisons montantes inopportuns et sélectionner des première et deuxième antennes (a, b) parmi lesdites plusieurs antennes correspondant aux premier et deuxième plus hauts niveaux de brouillage ;
   B_2) déterminer l'angle d'arrivée (α) dudit signal de liaison montante inopportun du premier plus haut niveau de brouillage en utilisant les diagrammes de rayonnement desdites première et deuxième antennes (a, b) ; et
   B_3) déterminer, pour chacune desdites voies, ledit plus haut niveau de brouillage en utilisant ledit angle d'arrivée.

2. Procédé dynamique d'assignation de voies selon la revendication 1, dans lequel l'étape B_2) comprend le fait de déterminer un premier gain relatif (Ga) du signal de liaison montante inopportun du premier plus haut niveau de brouillage en utilisant le diagramme de rayonnement de ladite première antenne (a) et un deuxième gain relatif (Gb) du signal de liaison montante inopportun du deuxième plus haut niveau de brouillage en utilisant le diagramme de rayonnement de ladite deuxième antenne (b), lesdits premier et deuxième gains relatifs (Ga, Gb) établissant une relation proportionnelle avec lesdits premier et deuxième plus hauts niveaux de brouillage, et dans lequel l'étape B_3) comprend le fait de déterminer ledit plus haut niveau de brouillage en utilisant le premier gain relatif (Ga).

3. Procédé dynamique d'assignation de voies pour une station de base d'un système de communication mobile, dans lequel la station de base possède plusieurs antennes (a, b, c, d ; a, b, c) et est capable de sélectionner une voie parmi l'ensemble des voies dudit système pour lesdites antennes ainsi que des zones de secteurs correspondantes, la station de base étant sensible à une demande d'appel pour une communication avec une station mobile dans le but d'évaluer les qualités desdites voies et d'assigner une des voies évaluées à la station mobile en fonction de leurs qualités, le procédé comprenant les étapes consistant à :

   A) déterminer, pour chacune desdites voies, les niveaux de brouillage de signaux de liaisons montantes inopportuns (Uupa, Uupb, Uupc, Uupd ; Uupx, Uupy ; Uupy1, Uupy2) reçus par l'ensemble desdites antennes ;
   B) déterminer, pour chacune desdites voies, le plus haut niveau (Uupi) desdits signaux de liaisons montantes inopportuns ;
   C) sélectionner une desdites voies en fonction du plus haut niveau (Uupi) de la voie sélectionnée par rapport aux plus hauts niveaux (Uupi) d'autres voies ;
   D) assigner la voie sélectionnée au poste mobile lorsque la voie sélectionnée possède une qualité acceptable ; et
   E) répéter les étapes C) et D) lorsque la voie sélectionnée ne possède pas une qualité acceptable,

   dans lequel un groupe unique de voies est attribué à chacune desdites antennes qui sont orientées dans des directions identiques vers les antennes d'autres stations de base, et

dans lequel l'étape A) comprend le fait de déterminer, pour chacune desdites voies, les niveaux (Uupx, Uupy) dudit signal inopportun détecté par des première et deuxième antennes (x, y) qui sont orientées en direction l'une de l'autre.

4. Procédé dynamique d'assignation de voies pour une station de base d'un système de communication mobile, dans lequel la station de base possède plusieurs antennes (a, b, c, d ; a, b, c) et est capable de sélectionner une voie parmi l'ensemble des voies dudit système pour lesdites antennes ainsi que des zones de secteurs correspondantes, la station de base étant sensible à une demande d'appel pour une communication avec une station mobile dans le but d'évaluer les qualités desdites voies et d'assigner une des voies évaluées à la station mobile en fonction de leurs qualités, le procédé comprenant les étapes consistant à :

A) déterminer, pour chacune desdites voies, les niveaux de brouillage de signaux de liaisons montantes inopportuns (Uupa, Uupb, Uupc, Uupd ; Uupx, Uupy ; Uupy1, Uupy2) reçus par l'ensemble desdites antennes ;
B) déterminer, pour chacune desdites voies, le plus haut niveau (Uupi) desdits signaux de liaisons montantes inopportuns ;
C) sélectionner une desdites voies en fonction du plus haut niveau (Uupi) de la voie sélectionnée par rapport aux plus hauts niveaux (Uupi) d'autres voies ;
D) assigner la voie sélectionnée au poste mobile lorsque la voie sélectionnée possède une qualité acceptable ; et
E) répéter les étapes C) et D) lorsque la voie sélectionnée ; ne possède pas une qualité acceptable,

dans lequel l'étape A) comprend le fait de déterminer, pour chacune desdites voies, des premier et deuxième niveaux de brouillage (Uupy1, Uupy2) desdits signaux inopportuns détectés respectivement par des première et deuxième antennes (y_1, y_2) qui forment un diagramme de rayonnement virtuel orienté dans une direction opposée au diagramme de rayonnement d'une troisième antenne (x) ;
dans lequel l'étape B) comprend le fait de :

B_1) déterminer l'angle d'arrivée (β) dudit signal inopportun en utilisant les diagrammes de rayonnement des première et deuxième antennes (y_1, y_2) ;
B_2) corriger un des niveaux de brouillage déterminés (Uupy1, Uupy2) en fonction dudit angle d'arrivée ; et
B_3) sélectionner le plus haut niveau de brouillage parmi le niveau de brouillage corrigé et le niveau non corrigé.

5. Procédé dynamique d'assignation de voies selon la revendication 4, dans lequel l'étape B_1) comprend le fait de déterminer un premier gain relatif (Gb) du signal inopportun du premier plus haut niveau de brouillage sur le diagramme de rayonnement de ladite première antenne (y_1), un deuxième gain relatif (Gc) du signal inopportun du deuxième niveau de brouillage sur le diagramme de rayonnement de ladite deuxième antenne (y_2), et un troisième gain relatif (Gv) du signal inopportun en utilisant ledit diagramme de rayonnement virtuel, lesdits premier et deuxième gains relatifs (Gb, Gc) établissant une relation proportionnelle avec les premier et deuxième niveaux de brouillage (Uupy1, Uupy2), et dans lequel l'étape B_2) comprend le fait de corriger le niveau de brouillage (Uupy1) du signal inopportun détecté par la première antenne (y_1) en utilisant les premier et troisième gains relatifs (Gb, Gv).

6. Procédé dynamique d'assignation de voies selon l'une quelconque des revendications 1 à 5, dans lequel l'étape C) comprend l'étape C_1) consistant à sélectionner une voie de liaison montante parmi plusieurs voies de ce type en fonction dudit plus haut niveau (Uupi) de la voie sélectionnée par rapport aux plus hauts niveaux (Uupi) d'autres voies, et dans lequel l'étape D) comprend l'étape D_1) consistant à assigner au poste mobile la voie de liaison montante sélectionnée et une voie de liaison descendante correspondante.

7. Procédé dynamique d'assignation de voies selon la revendication 6, dans lequel l'étape D) comprend les étapes consistant à :

transmettre au poste mobile un support dudit canal de liaison descendante correspondant ; et
donner ordre au poste mobile de déterminer la qualité du support transmis et informer la station de base concernant la qualité déterminée.

FIG. 1

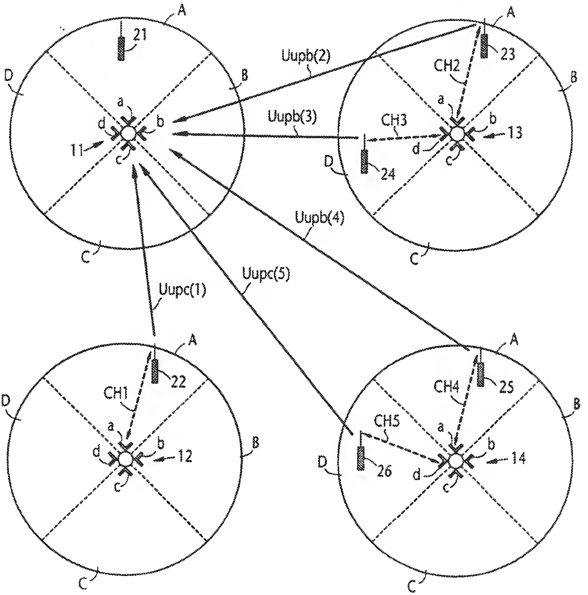

A
21
D
B
a
d
b
11
c
C
A
23
CH2
B
a
b
CH3
13
d
c
D
24
C
Uupb(2)
Uupb(3)
Uupb(4)
Uupc(1)
Uupc(5)
A
22
CH1
D
a
d
b
12
c
B
C
A
25
CH4
B
CH5
a
b
D
26
d
14
c
C

FIG. 2

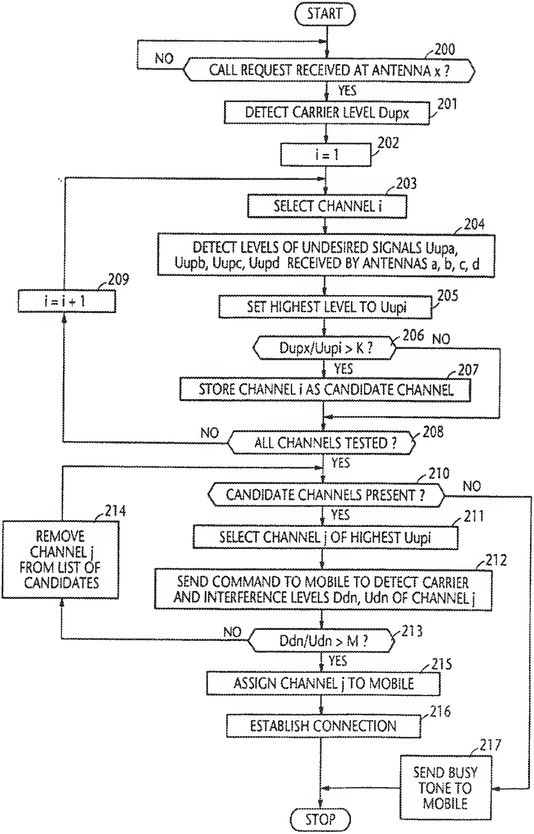

START
NO
200
CALL REQUEST RECEIVED AT ANTENNA x ?
YES
DETECT CARRIER LEVEL Dupx
201
i = 1
202
SELECT CHANNEL i
203
DETECT LEVELS OF UNDESIRED SIGNALS Uupa, Uupb, Uupc, Uupd RECEIVED BY ANTENNAS a, b, c, d
204
SET HIGHEST LEVEL TO Uupi
205
i = i + 1
209
Dupx/Uupi > K ?
206
NO
YES
STORE CHANNEL i AS CANDIDATE CHANNEL
207
NO
ALL CHANNELS TESTED ?
208
YES
CANDIDATE CHANNELS PRESENT ?
210
NO
YES
SELECT CHANNEL j OF HIGHEST Uupi
211
REMOVE CHANNEL j FROM LIST OF CANDIDATES
214
SEND COMMAND TO MOBILE TO DETECT CARRIER AND INTERFERENCE LEVELS Ddn, Udn OF CHANNEL j
212
NO
Ddn/Udn > M ?
213
YES
ASSIGN CHANNEL j TO MOBILE
215
ESTABLISH CONNECTION
216
SEND BUSY TONE TO MOBILE
217
STOP

FIG. 3

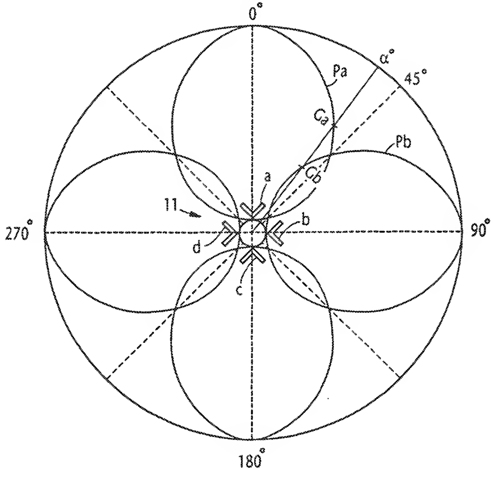


FIG. 4

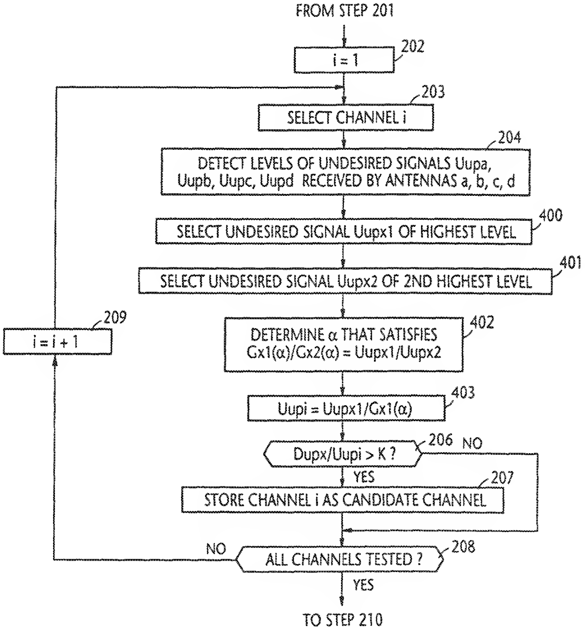
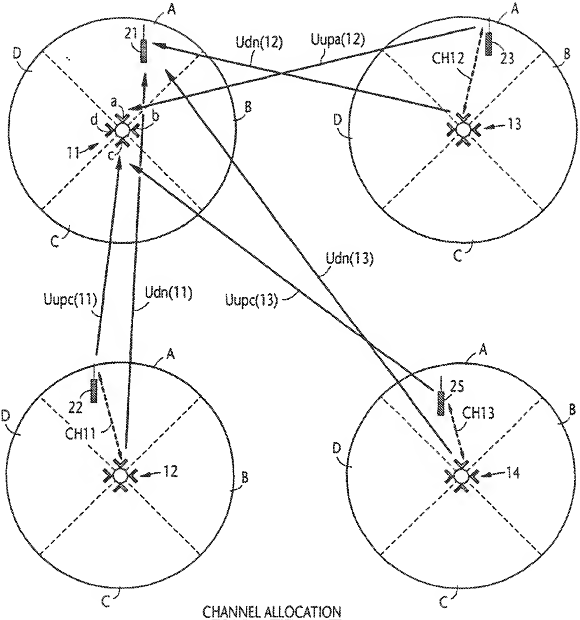

FROM STEP 201
i = 1
202
203
SELECT CHANNEL i
204
DETECT LEVELS OF UNDESIRED SIGNALS Uupa, Uupb, Uupc, Uupd RECEIVED BY ANTENNAS a, b, c, d
400
SELECT UNDESIRED SIGNAL Uupx1 OF HIGHEST LEVEL
401
SELECT UNDESIRED SIGNAL Uupx2 OF 2ND HIGHEST LEVEL
209
i = i + 1
402
DETERMINE α THAT SATISFIES Gx1(α)/Gx2(α) = Uupx1/Uupx2
403
Uupi = Uupx1/Gx1(α)
206
NO
Dupx/Uupi > K ?
YES
207
STORE CHANNEL i AS CANDIDATE CHANNEL
NO
ALL CHANNELS TESTED ?
208
YES
TO STEP 210

FIG. 5



CHANNEL ALLOCATION

SECTOR A = CHANNEL GROUP 1 (CH11, CH12, CH13,....)
SECTOR B = CHANNEL GROUP 2 (CH21, CH22, CH23, ...)
SECTOR C = CHANNEL GROUP 3 (CH31, CH32, CH33, ...)
SECTOR D = CHANNEL GROUP 4 (CH41, CH42, CH43, ...)

FIG. 6

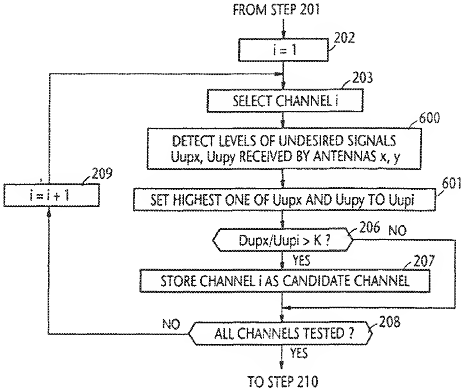

FROM STEP 201
i = 1
202
203
SELECT CHANNEL i
600
DETECT LEVELS OF UNDESIRED SIGNALS Uupx, Uupy RECEIVED BY ANTENNAS x, y
209
i = i + 1
601
SET HIGHEST ONE OF Uupx AND Uupy TO Uupi
Dupx/Uupi > K ?
206
NO
YES
207
STORE CHANNEL i AS CANDIDATE CHANNEL
NO
ALL CHANNELS TESTED ?
208
YES
TO STEP 210

FIG. 7

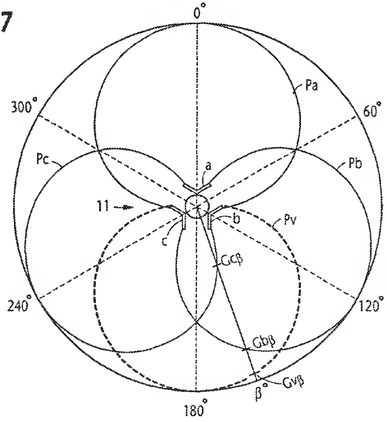
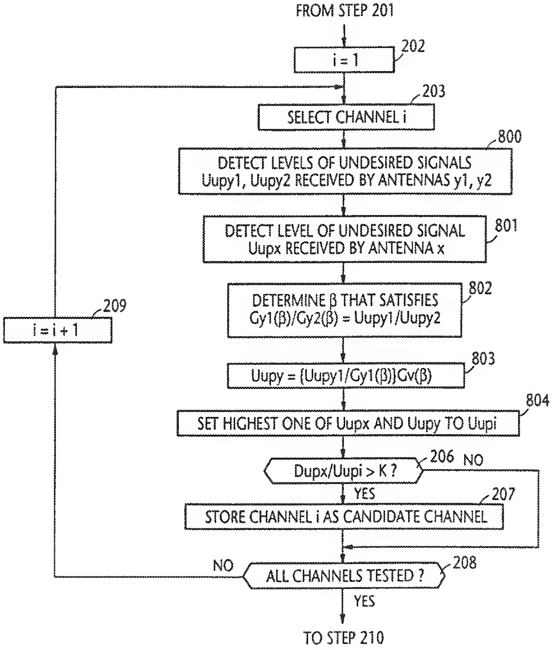

0°
Pa
300°
60°
Pc
Pb
a
11
b
Pv
c
Gcβ
240°
120°
Gbβ
β°
Gvβ
180°

FIG. 8


FROM STEP 201
i = 1
202
203
SELECT CHANNEL i
800
DETECT LEVELS OF UNDESIRED SIGNALS Uupy1, Uupy2 RECEIVED BY ANTENNAS y1, y2
801
DETECT LEVEL OF UNDESIRED SIGNAL Uupx RECEIVED BY ANTENNA x
802
DETERMINE β THAT SATISFIES Gy1(β)/Gy2(β) = Uupy1/Uupy2
209
i = i + 1
803
Uupy = {Uupy1/Gy1(β)}Gv(β)
804
SET HIGHEST ONE OF Uupx AND Uupy TO Uupi
206
NO
Dupx/Uupi > K ?
YES
207
STORE CHANNEL i AS CANDIDATE CHANNEL
NO
ALL CHANNELS TESTED ?
208
YES
TO STEP 210